

Near Far tracking & MC re-weighting of DIS/RES region

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Outline

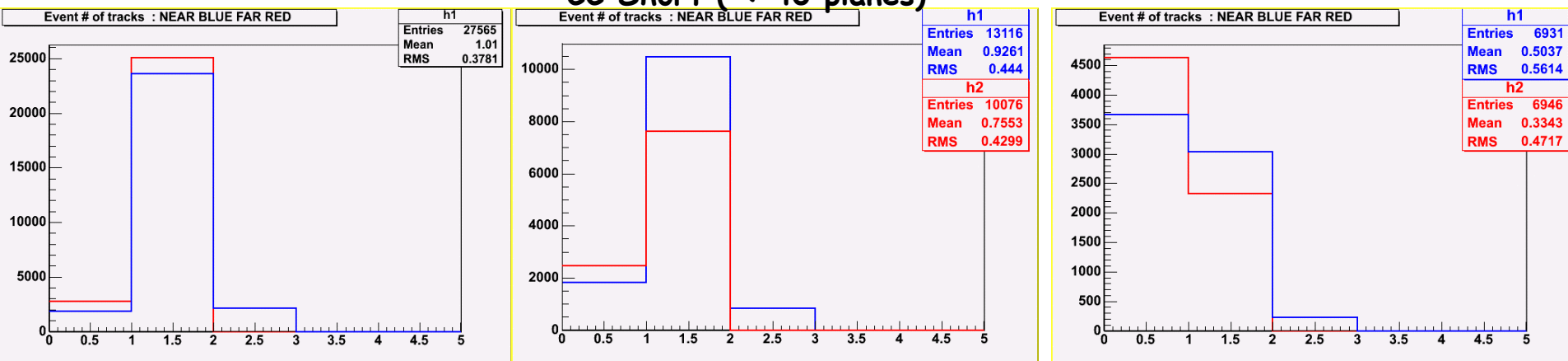
- Near Far Reco differences
 - Near Far tracking efficiency (CC & NC)
 - Current code
 - Modified code
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- Study of DIS/RES region for CC events (initial results)
 - Summary - On going work

Near Far Reco differences

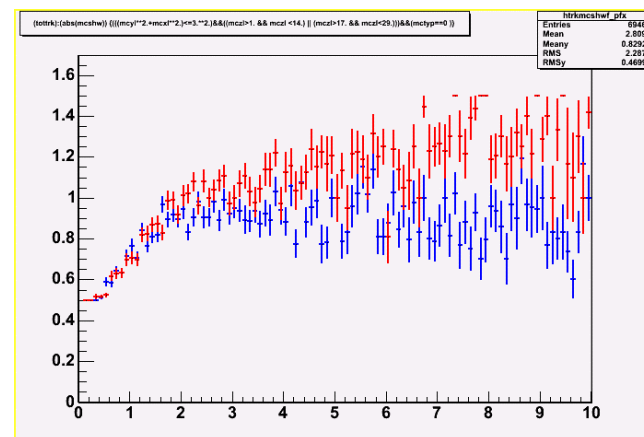
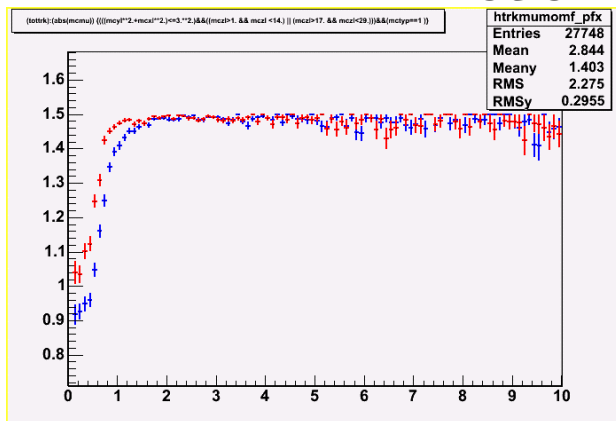
- In previous Reco and Physics analysis meetings (NC & CC) I have been comparing truth and reco quantities in the Near and Far detectors in order to identify, understand and correct if possible differences in “important” reconstructed quantities.
- The comparisons so far revealed rather drastic tracking and showering differences that can affect both event selection (CC/NC) and reconstructed neutrino energy spectra in a different way in Near and Far detectors.
- It was suggested in the collaboration meeting that a nice way of trying to understand the differences is to study the exact same events in both detectors.
- I have made some progress as far as NF tracking efficiencies are concerned and I plan to further study tracking and muon momentum estimation differences in more detail using Panos S. “same” event files in Near and Far. (more details in his talk)

ND Reconstruction, things that are not yet well understood

Number of Tracks for CC & NC Events Near - Far



COLOR CODE : RED NEAR - BLUE FAR



CC : % reconstructed tracks vs Pmu true

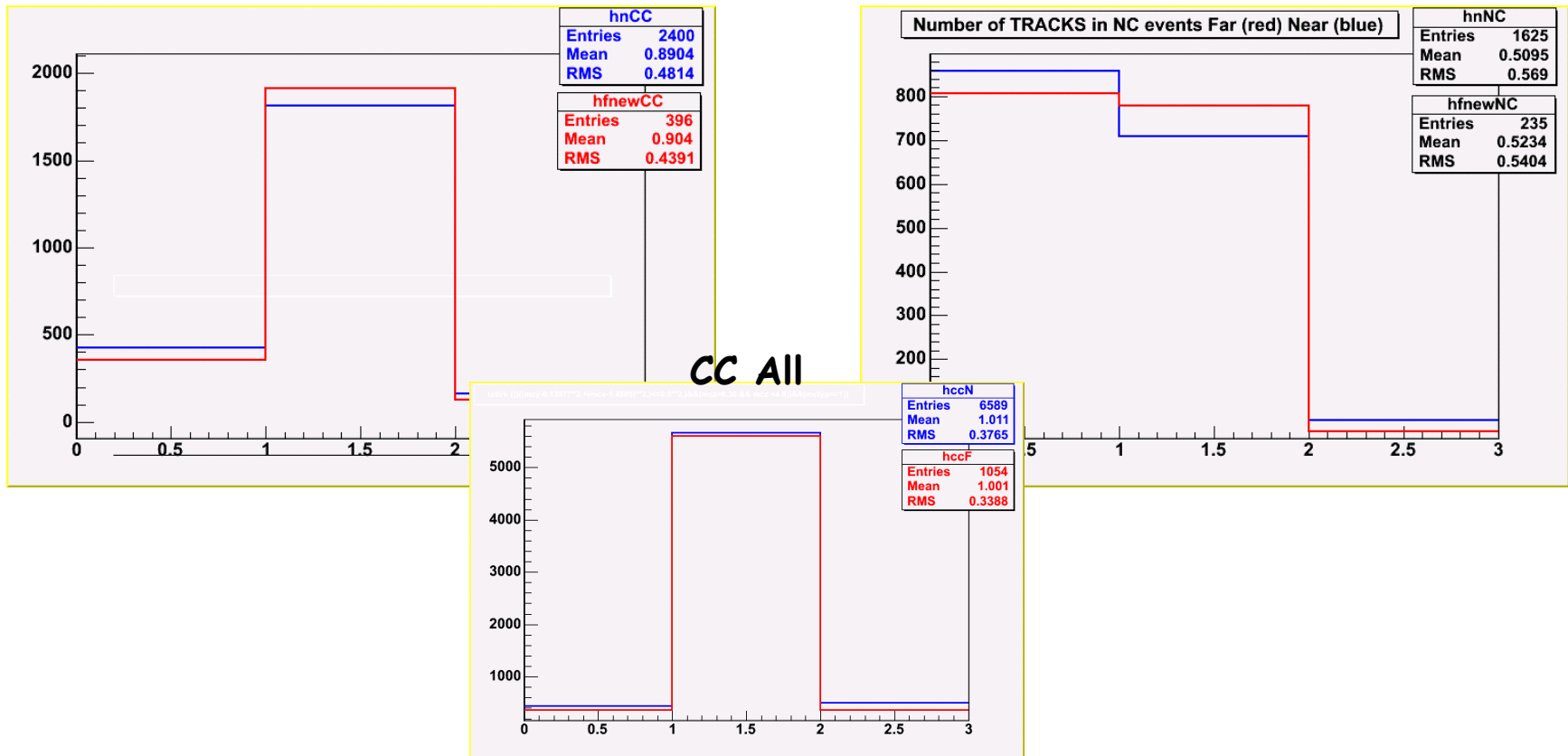
NC : % reconstructed tracks vs Eshw true

- The percentage of reconstructed tracks in the NEAR detector is higher than in the FAR and that is not a geometric effect. It is due to the looser reconstruction code cuts for the NEAR detector. (Me & Panos are currently working on that and will have results soon)

Number of Tracks for CC & NC Events Near - Far NEW

CC Short (< 40 planes)

NC All



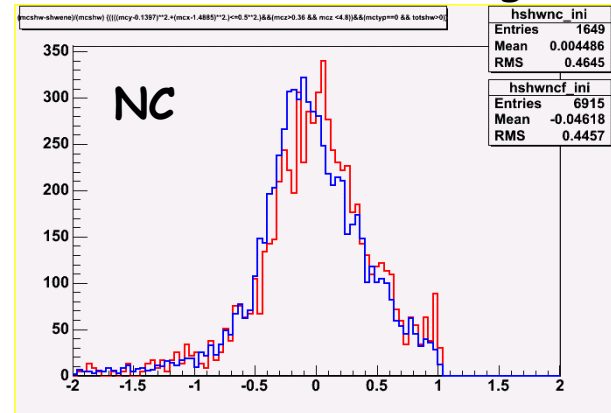
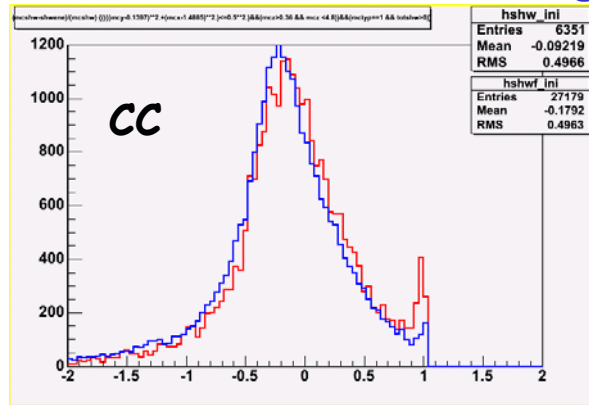
- The tracking efficiency is now the same between Near & Far detector.
- Changed FAR tracking criteria to be exactly the same as NEAR and that increased the FAR tracking efficiency for both CC and NC events.
- That clearly proves that the initial difference in tracking efficiencies between Near and Far was mainly a code effect.

Number of Tracks for CC & NC Events Near - Far NEW con't

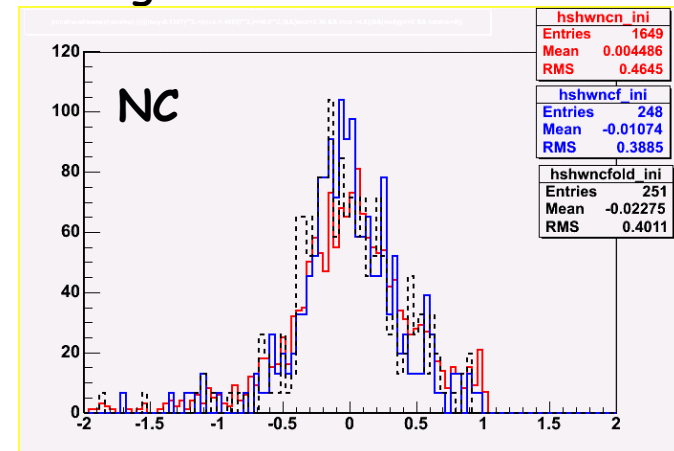
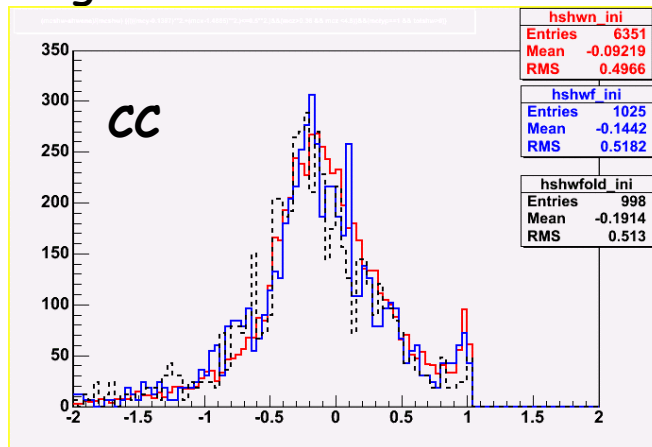
- The fact that now tracking efficiencies between Near and Far are similar and understood is good.
- However one has to think how to proceed :
 - 1. Change FAR cuts (as I did to understand the effect which means looser tracking in the Far as well)
 - 2. Change NEAR cuts (More conservative tracking that will certainly cost on tracking efficiency in the sparse region of the detector)
 - 3. Leave things as they are ?
- I would certainly not go with 3... for mainly two reasons:
 - Tracking efficiency differences might introduce differences in event classification (track events are more CC-like than non-track events)
 - Shower (and therefore total) energy estimation differences. "Wrong" tracks in NC events reduce the estimated shower energy. Lack of true muon tracks in CC events increase the estimated shower energy and the event energy. Therefore Shower energy in Near detector would be higher than in Far (which is something that we see)...

Number of Tracks for CC & NC Events Near - Far NEW con't

... Therefore Shower energy in Near detector (**red histogram**) would be higher than in Far (**blue histogram**) (which is something that we see)...



- The difference in shower energy between Near-Far seems to decrease (given statistics, I need to check with more events) with the changes in tracking cuts that made Near Far tracking efficiencies similar.



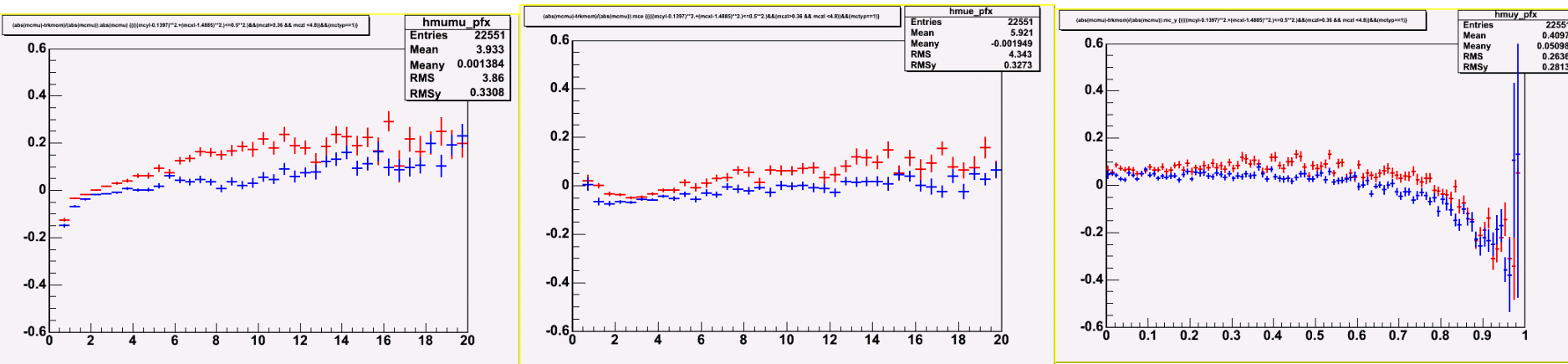
(Eshtrue-Eshwreco)/Eshwtrue

Number of Tracks for CC & NC Events Near - Far NEW con't

- Given the previous observations on shower energy estimation (that I want to verify and quantify better using more events) tracking needs to become similar between Near and Far.
- Jim M. has already started working on changing (I believe) Near tracking parameters to :
 - 1. Make them more reasonable for the Near Det. dense region.
 - 2. Make Near - Far tracking more similar.

ND Reconstruction, things that are not yet well understood

Estimated muon momentum (Dp/p) vs Pmu Enu and Y Near - Far



COLOR CODE : RED NEAR - BLUE FAR

- Profiling histograms of Dp/p (True - Reco/True) vs Pmu true, Enu true and Y.
- Near detector shows systematically lower estimated muon momentum than true and than the FAR detector.
- Alysia Marino is currently working on correcting estimation of momentum from range that is currently incorrect and different for Near & Far (due to different geometry of dense and sparse regions).
- I am looking into that from a different perspective more track reconstruction related... (Work in Progress)

MC Reweighting for DIS/RES study.

- Chris, Costas and Hugh have wrote the re-weighting package that allows users to change various important Neugen parameters in order to study:
 - Systematic uncertainties in the MINOS Physics measurements
 - The possibility of using ND data to better constraint these parameters and thus reduce systematic uncertainties (and also do a better MC tuning).
- I have started studying the DIS / Resonance region using the available Neugen Interface parameters for CC events (at the moment).

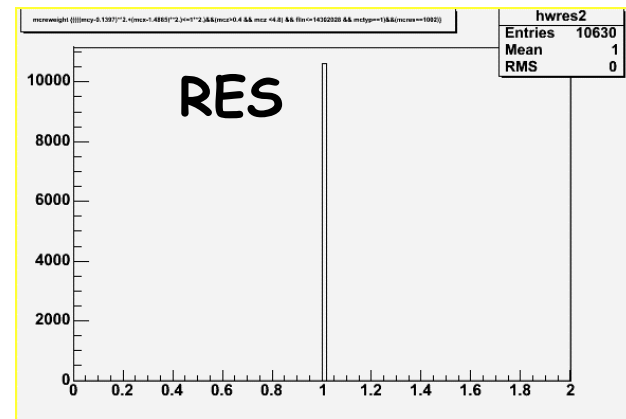
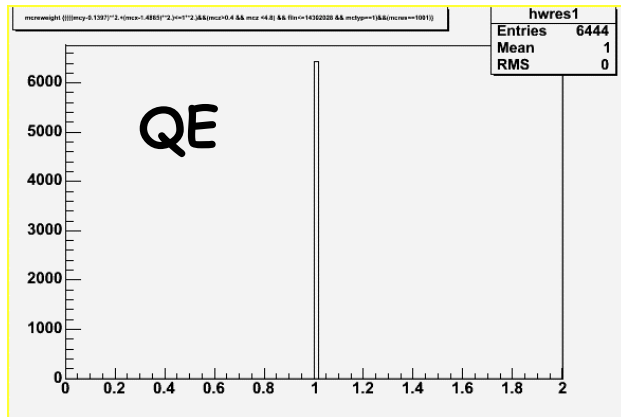
DIS/RES study at the ND : Strategy

- Change (in a reasonable way) the 8+8 DIS/RES model tuning factors of Neugen.
- Examine the resulting changes in truth and reconstructed quantities.
- Select a “clean” sample of events sensitive mostly to these Neugen factor changes.
- Use reconstructed (observable) distributions of this “clean” sample to examine whether it is possible to better estimate (constraint) these factors.

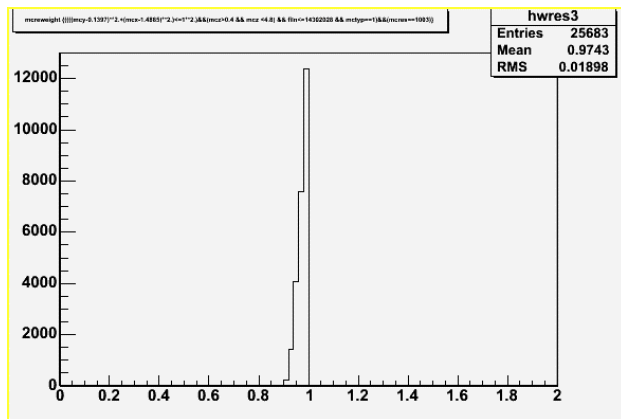
DIS/RES factors

- So far I have changed the 8 DIS/RES Neugen model tuning factors for CC events : kno_{1YZ} $Y=(1,2,3,4)$ for $(\nu\text{-}p, \nu\text{-}n, \bar{\nu}\text{-}p, \bar{\nu}\text{-}n)$, and $Z=(2,3)$ for final state multiplicity by $\pm 10\%$
- I don't know if these parameters are correlated (they should be) and if it is reasonable to increase and decrease all of them by the same amount on the same time.
- I do know that the re-weighting scheme is not correct (Hugh send a detailed e_mail yesterday) but that does not really affect my study at this point because I am just starting.

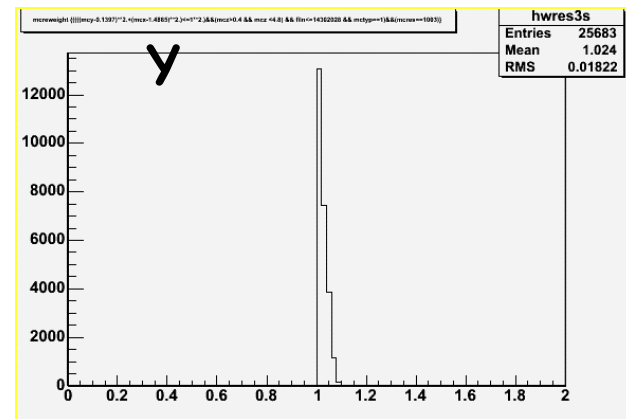
DIS/RES CC Weights



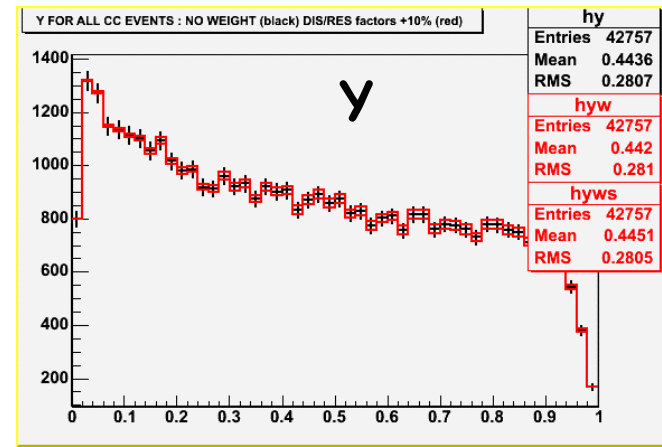
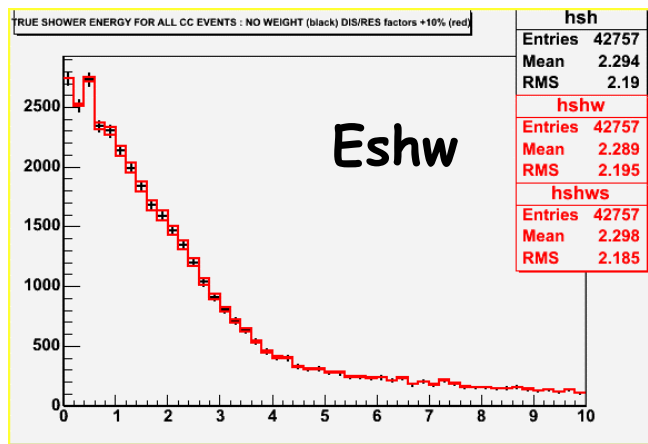
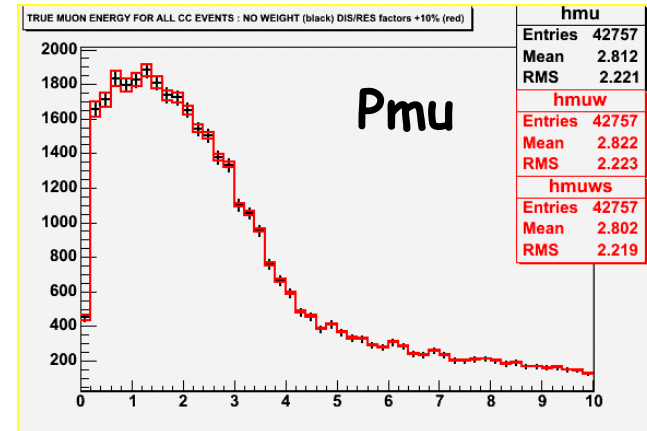
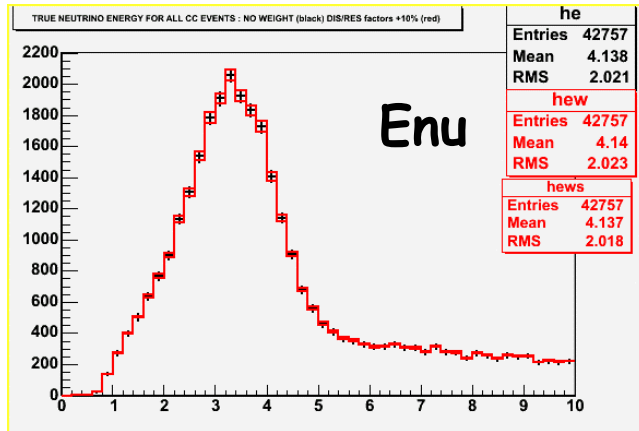
DIS (ires = 1003) -10%



DIS (ires = 1003) +10%

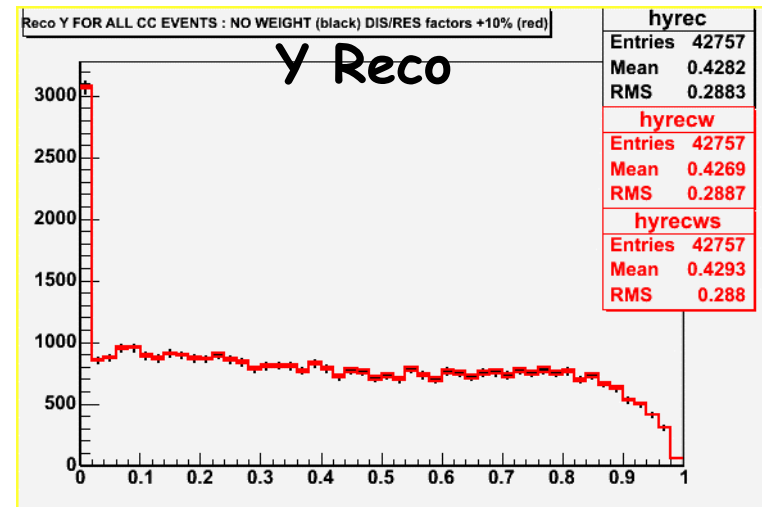
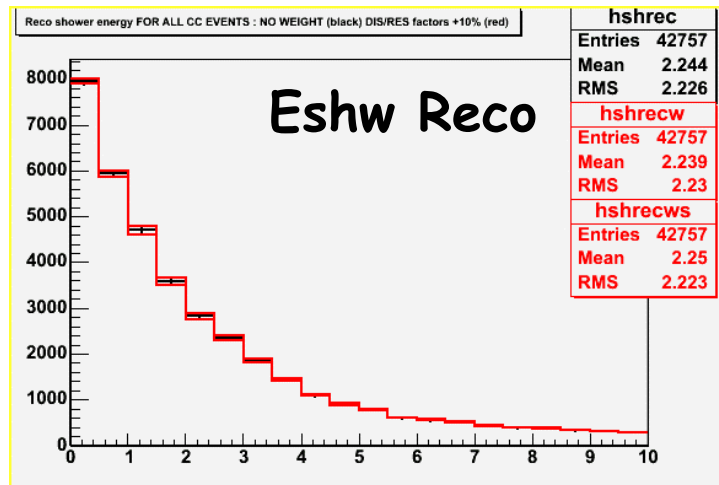
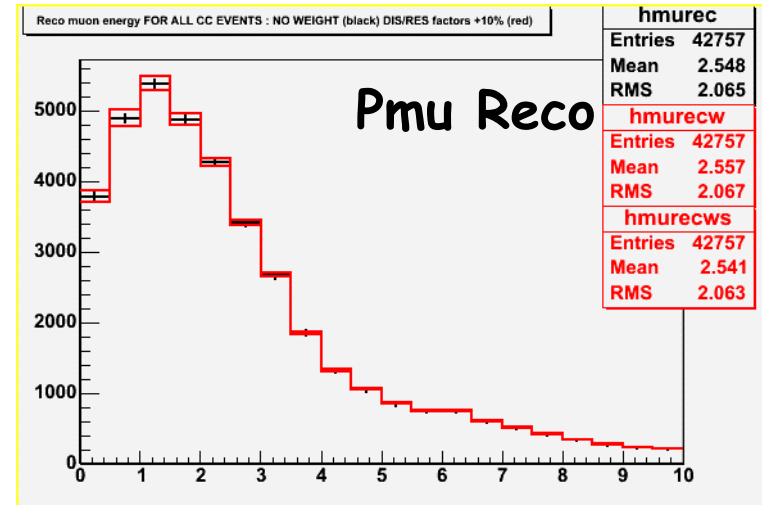
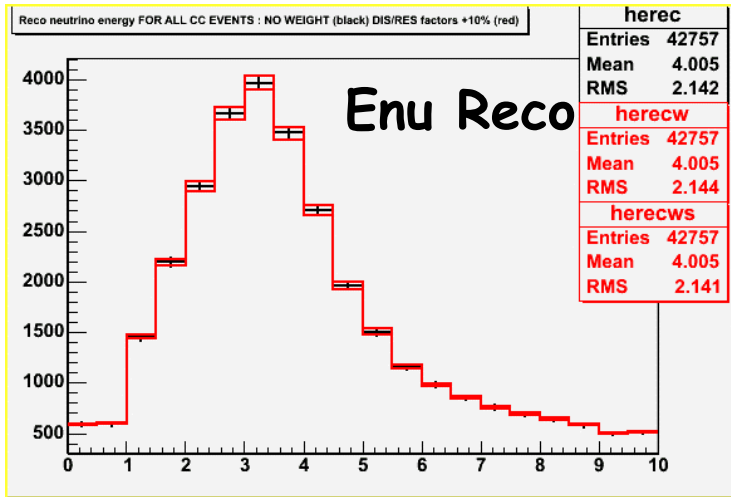


CC DIS/RES factors changed by $\pm 10\%$: Truth Quantities



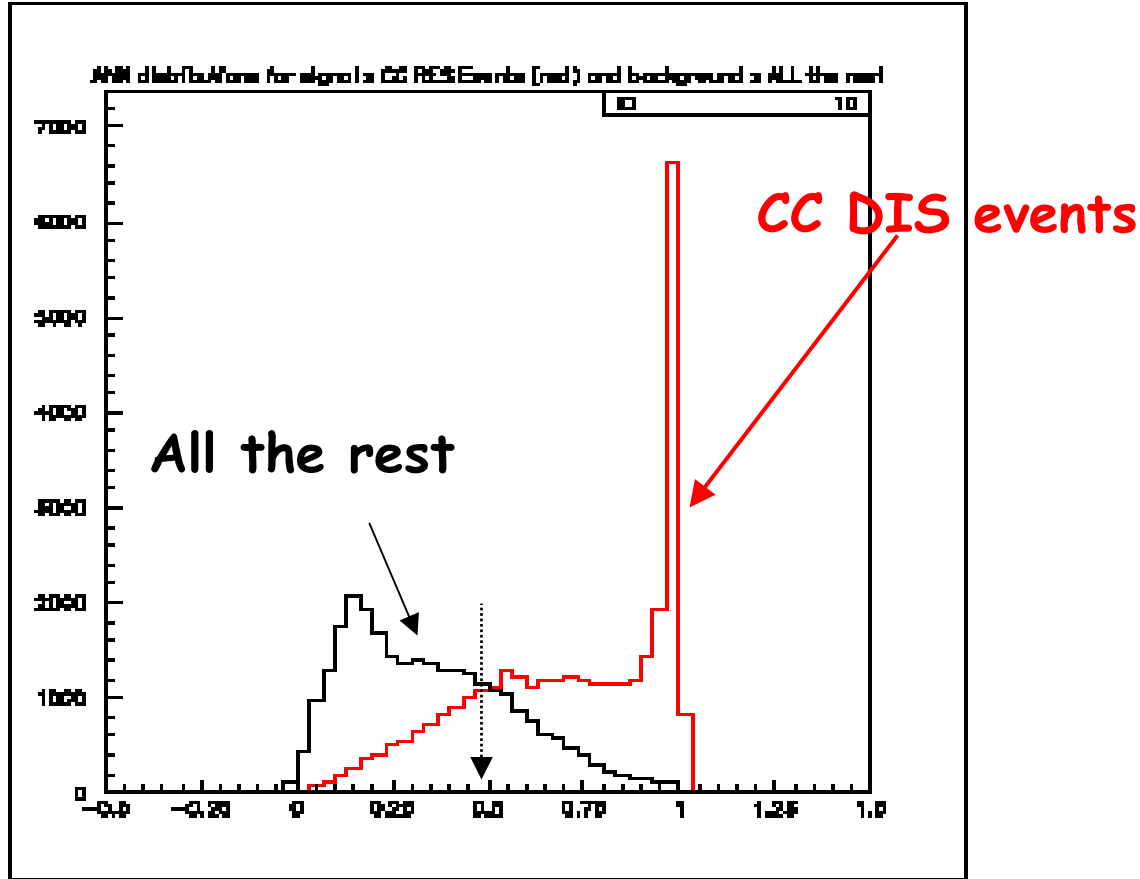
- Black histogram is the MC with weight of 1 and the red histograms correspond to $\pm 10\%$ in all 8 DIS/RES neugen factors.
- There is an increase (decrease) by some amount mostly in the region of $\sim 2-4$ GeV (neutrino energies)

CC DIS/RES factors changed by $\pm 10\%$: Reco Quantities



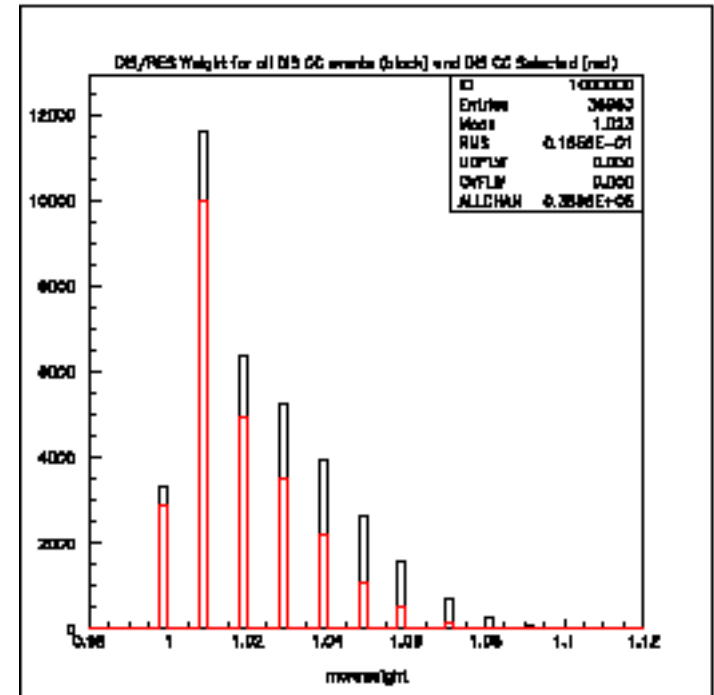
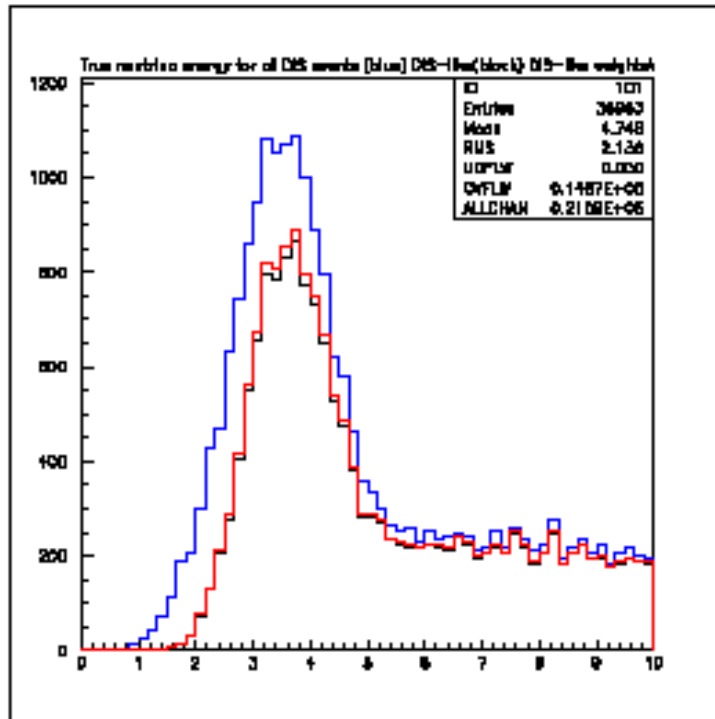
- Black histogram is the MC with weight of 1 and the red histograms correspond to $\pm 10\%$ in all 8 DIS/RES neugen factors.
- There is an increase (decrease) by some amount mostly in the region of $\sim 2-4$ GeV (reco neutrino energies).

Select a "clean" sample of CC DIS events
sensitive to Neugen DIS/RES CC factors



- Constructed an ANN to select CC DIS events from all the rest. The events are required to have a track and a shower (this was found to give the best results).

Select a "clean" sample of CC DIS events sensitive to Neugen DIS/RES CC factors cont'd



All CC DIS

ANN selected CC DIS

ANN selected CC DIS weighted (DIS/RES +10%)

Weight of all CC DIS

Weight of ANN selected CC DIS

- ANN selected DIS CC events are not only high energy.
- That means that they have some sensitivity in the DIS/RES CC factors (as seen from the ANN selected event weights).

Summary-On going work

- I am working on understanding Near Far reco related issues that I (or other people) raised in the Collaboration meeting.
 - At the moment I am focusing on tracking differences.
 - The tracking efficiency difference I believe is now understood and Jim M. has already started changing tracking cuts/code towards that direction.
 - Next I plan to closely investigate differences in estimation of muon momentum between Near & Far using also Panos S. "exact same events" in Near and Far detector.
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- I have started looking at the DIS/RES region using MC re-weight package focusing at the moment in the ND and how to use it to better constraint (if possible) these parameters.
 - I plan on further working towards that direction until either I hit a wall or find a way of using ND to better constraint DIS/RES factors.
 - I need to find out (by asking the experts I guess) how much these parameters are "allowed" to vary. Given that I want to examine what the impact of this uncertainty is on the Far Detector measurement (if it is minimal there is no need to try to constraint them further...)
 - More hopefully on the next meeting.